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31 Jul 1965, DoDD 5200.10; ONR ltr, 9 Nov 1977	

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AD/7200

Cessna
Aircraft Company
Wichita, Kansas

Engineering Report

May 25 through July 13, 1953

MODEL ~~309A~~ 309C : REPORT NO. 8
~~319A~~

APPLICATION OF CIRCULATION CONTROL TO
AN AIRPLANE OF MILITARY LIAISON TYPE

UNDER CONTRACTS 234(C2) AND 256(C2)

REPORT DATE: July 22, 1953

PREPARED BY: Earl G. Blosser

Jack W. Fisher

APPROVED BY: Alex N. Petroff

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CESSNA MODEL 309A and 309C - NON-CONTRACT 234(00)Analysis

During this period all data reduction for Model 309A take-off and landing tests has been completed and all take-off and landing tests have been replotted for reproduction. Report No. 1309-9, Flight Test Observed and Corrected Data Report has been written and is nearly ready for release.

Calculations are now being made for use in Report No. 1309-10, Flight Test Performance Data Report, which will contain results and analysis of take-off and landing tests of Model 309A.

The most significant improvement in performance due to boundary layer control (BLC) appeared in the reduction of air distance over a 50 foot obstacle during take-off. This has been attributed to differences in effective thrust (thrust minus drag) at climb-out speeds. For the case with BLC operating this speed was lower so that greater propeller thrust was developed. In addition the physical magnitude of drag in pounds was smaller even though the drag coefficient with BLC was greater. The overall effect increased the angle of climb-out to the extent that substantial reduction in air distance occurred.

Model 309C (Hydrogen Peroxide Jet Pump)

The following personnel of Reaction Motors, Inc. arrived on June 16, 1953.

Arthur Brukardt, Asst. Project Engineer
Jack Singleton, Service Representative
Gabriel Yanvary, Service Representative

Pre-installation ground tests were performed on the H_2O_2 jet pump system during the week of June 29. The unit was tested for total eight minutes of operation. No malfunctions or unusual system operation was observed.

The unit is now being installed in the airplane for flight test purposes. (Reference Photograph #5) The following items remain to be completed before the airplane is ready for flight test:

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FORM 474

1. Pressure check H_2O_2 unit
2. Install and rig flaps
3. Weigh airplane
 - a. Empty
 - b. With pilot and fuel
4. Install and hook up manometer rack
5. Install camera
6. Install audiograph
7. Ground test H_2O_2 unit
 - a. Without engine operating
 - b. With engine operating

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MODEL 309A-309C-319A

FORM 484

CESSNA MODEL 319A - HONOR CONTRACT 356(CO)Analysis

The analysis of elevator deflection required to land indicated that considerable modification to a standard L-19 tail will be required. The computations show that this present tail has insufficient power to 3-point the airplane with flaps full down and ailerons drooped. This difficulty has been experienced with the Cessna Model 309A, and is being corrected on that airplane by adjustment of horizontal stabilizer incidence and a small increase in elevator area. Due to considerable larger pitching moments expected from the 319A H₂O wing the simple changes which are being made to the 309 tail would not be sufficient.

Since the aerodynamic and structural design of an entirely new horizontal tail is expensive and time consuming, a Cessna Model 180 variable incidence horizontal tail was considered. It was found that the use of this tail alleviated the problem considerably, and steps are underway to incorporate it on the 319A. Even with this improved tail it may become necessary to add elevator area and impose new limitations on the forward center of gravity location. These factors will be resolved during preliminary flight tests.

It should be noted that all computations have been based upon the standard downwash and wake location charts (NACA APR 14116 and NACA TR 648). Some question exists as to the validity of these charts for wings developing the high lift coefficients associated with HLC (or circulation control); therefore, in all cases where downwash angle and dynamic pressure in the wake were estimated the results must be considered preliminary. Verification of these assumptions is needed not only for specific application to the Cessna Model 319A but also

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FORM 484

for use in the general field of ELC aircraft. Many of the unknown factors can be established by wind tunnel tests of a three-dimensional ELC model with and without horizontal tail and with and without ground board. Since neither the time nor the funds currently exist for performing such tests on a model of the 319A this problem will be worked out during preliminary flight tests.

Design

Increased wing thickness and a change in planform, from the wing used on the L-19A, necessitates the use of a new wing strut on the 319A. Drawing 12319-12, Wing Strut Assembly, showing the new strut complete with new end fittings, has been released to the shop.

It was decided to use fiber glass wing tips on the Model 319A. This decision was reached after comparing the cost of both metal and fiber glass parts. The cost of the fiber glass tips is approximately one half the cost of aluminum tips. Drawing 12319-21 Wing Tip Assembly, shows the construction and installation details for these tips.

All structural modifications to the center section of the airplane: fuselage are shown on drawing 12319-7. These include a new rear spar carry-thru, window modifications and new wing fairings.

With the completion of drawing 12319-20 Flap Installation, the flap rib contours have been added to 12319-15 Wing Loft.

Both the flap drawing and drawing 12319-22 Aileron Installation will show not only the control surfaces, but also control linkages required for the proper operation of these surfaces.

Model 319A fuel tank installation includes the details of tank manufacture as well as a schematic of the entire fuel system. This drawing is finished and has been released to the shop.

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Empennage installation, drawing 12319-23, has been started. This drawing will show the installation of the complete Model 180 empennage assembly on the 319A.

Shop

All structural components of the wings, forward of the rear spar have been manufactured. These parts are now in the process of assembly. (Reference Photographs 2 and 3)

Work on the control surfaces has been started. To date form blocks for forming the flap ribs and flap leading edge have been made. As soon as possible form blocks for the aileron ribs will be made.

The fuel tanks for the wings are nearing completion (Reference Photograph #3). The filler neck and fitting remain to be installed. When these items are installed the tanks will be pressure tested to an internal pressure of 3.5 psi.

Re-work of an L-19A fuselage has been started. To date the new rear spar carry-thru and the required window modifications have been completed.

Static Test

The engine mount to be used on the 319A was static tested to 100% design load for all four conditions. No permanent set was encountered so it was decided to use the test engine mount on the airplane instead of constructing a new one for the purpose. (Reference Photograph #1)

Mock-Up

Tests, required to furnish design information for the full scale 319A suction duct, have been completed on the half scale section duct mock-up. Measurements of slot width, vane location and vane curvature are now being recorded. Actual duct design will begin as soon as possible. (Reference Photograph #4)

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Current Status of Purchased Parts

Axial Fan

Mr. C.P. Jenkins, Assistant Chief Engineer, Joy Manufacturing Co., New Philadelphia, Ohio, now advises that Cessna can expect delivery of the axial fans between 15 August and 1 September, 1953. Joy also has requested temporary loan of one hydraulic motor to conduct performance tests on the fan units. Arrangements have been made with Mr. William Main, Jr., of Vicker's to supply Joy with one of the units to be purchased by Cessna.

Hydraulic Pump and Motors

Vicker's Inc., of Detroit, Michigan were unable to supply the hydraulic pump directly; however, they did locate pumps in Navy terminal stock which were not directly assigned to a specific project. The Office of Naval Research through Mr. M.R. Lipman, Resident Representative, has obtained indefinite loan of two of these pumps. They are to be forwarded to Vicker's for inspection before usage.

Final design of the hydraulic system is being completed, and receipt of the line diagram from Vicker's is expected before 20 July 1953. Originally, Vicker's indicated that delivery of all system components would be achieved by early July; however, delay has been caused by inability to supply the pump, and present indications are that some difficulty may be expected with delivery of the motors. As a result, at the present time, no definite delivery date can be confirmed by Vicker's.

Engines

The engine provided with special gears for a hydraulic pump drive is now expected to be delivered during the week of 3 August, 1953. Delay by Continental Motors has been due to procurement of the gears.

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Propellers

Final arrangements for the delivery of two propellers has been completed with Hartzell Propeller Company, Piqua, Ohio. Both propellers are to be flight tested and one returned without cost. Delivery to Cessna is scheduled for the week of 13 July, 1953.

Miscellaneous

Plans for bench tests of various methods for BLC power transmission, other than hydraulic, have been altered considerably since the time of last reporting. The electrical system has been abandoned after discussion by Cessna personnel with Major J. Wilcox (ONR), Mr. R. Putnam and Mr. J. Beach (Office of the Chief of Transportation, U.S. Army). The development cost of the solid propellant system proposed by General Electric Company exceeds the financial limitations of the present contract. Therefore the following companies were invited to make proposals of solid and liquid propellant gas generator systems utilizing existing turbine wheels:

AiResearch Mfg. Co., Los Angeles, California
Turbo Products Inc., Pasadena, California
Aerojet-General Corp., Azusa, California
Reaction Motors, Inc., Dover, New Jersey

Preliminary survey indicates that several light weight, compact package-power units have been developed for missile application. It is possible that at least two can be adapted to our needs as turbo-fan units.

Personnel

During this period three additional engineers have been added to the analysis section. Their full time activities will be devoted to the Cessna Models 309C (hydrogen peroxide jet pump) and 319A. Education and experience of each man is as follows:

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FORM 424

<u>Name</u>	<u>Yrs. of College</u>	<u>Degree</u>	<u>Yrs. Engr. Experience</u>
Gordon Luessen	3 3 1/2	----	1/2
Dean Johnson	5	B.S. (Aero)	1/2
John Smith	4	B.S. (Aero)	1/2

Trips

Mr. A. N. Petroff and Mr. J. W. Fisher visited Washington, D.C. on June 23 and 24, 1953. The purpose of the trip was to attend the IAS symposium on boundary layer control held the 24th. In addition, on June 23rd a conference was conducted at the offices of the U.S. Army Chief of Transportation. Attending, in addition to Cessna personnel, were:

Major J. Willcox, ONR
Mr. R. Putnam, U.S. Army
Mr. J. Beach, U.S. Army
Mr. K. Razak, University of Wichita

Mr. Putnam and Mr. Beach disclosed a plan for an orientation lecture to be presented before Army personnel at some date prior to demonstration of the 319A. This met with agreement by Cessna, and the lecture date will be established when a firm initial flight date is known. It was felt that the time period between lecture and demonstration should be as short as possible. Final delivery date of all purchased parts fixes the initial flight date, and it is expected to be established by the week of July 20, 1953.

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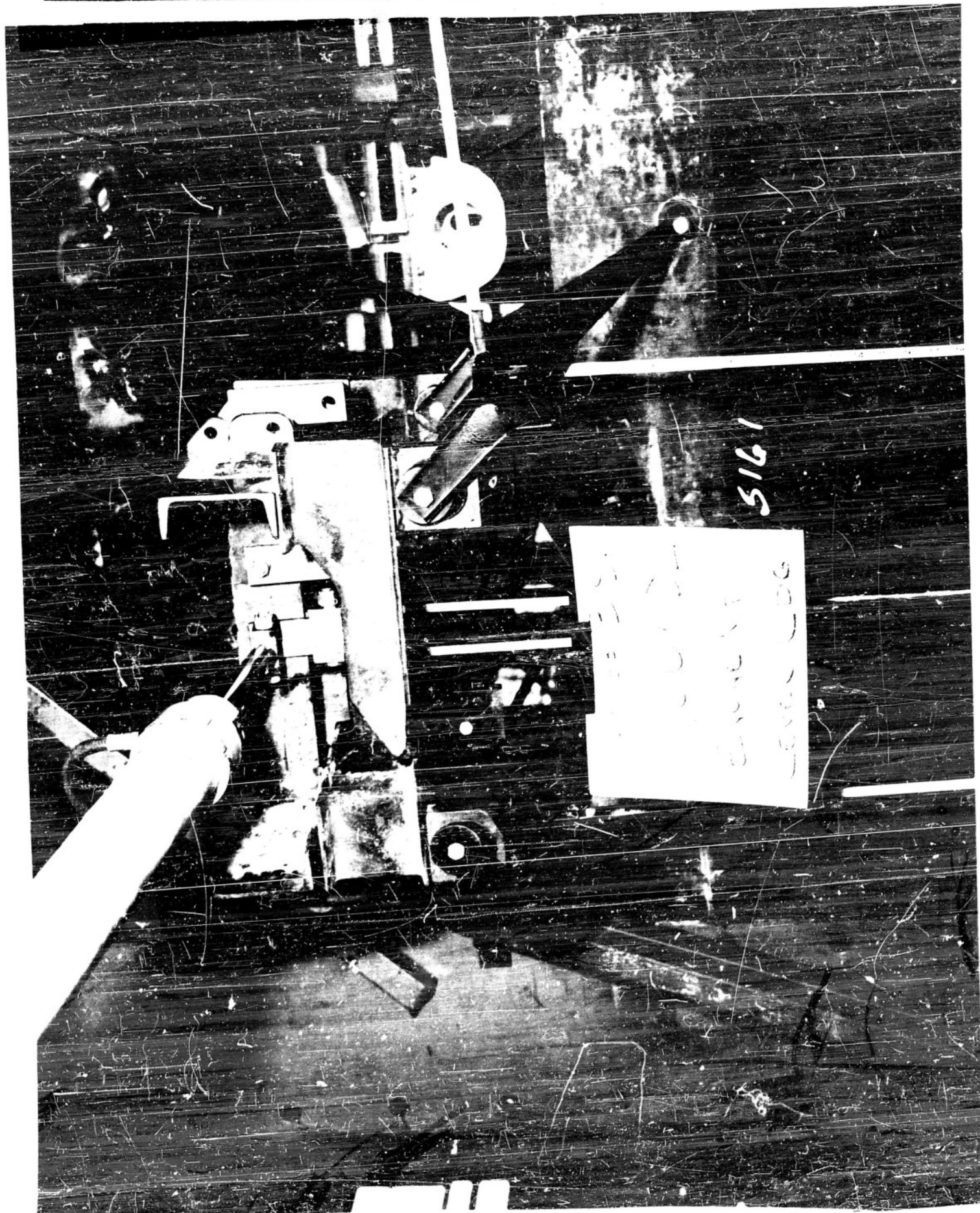
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Photograph No. 1



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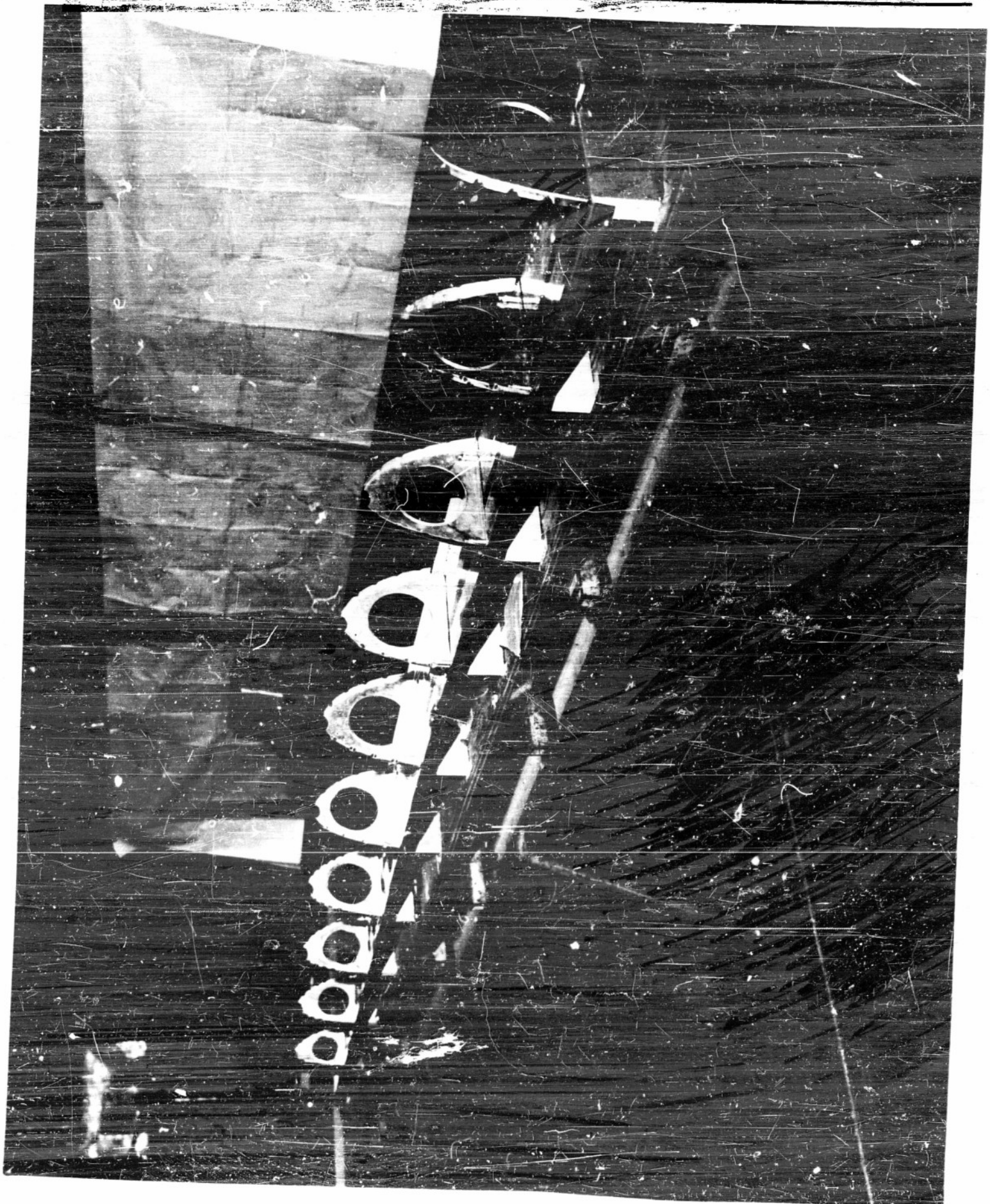
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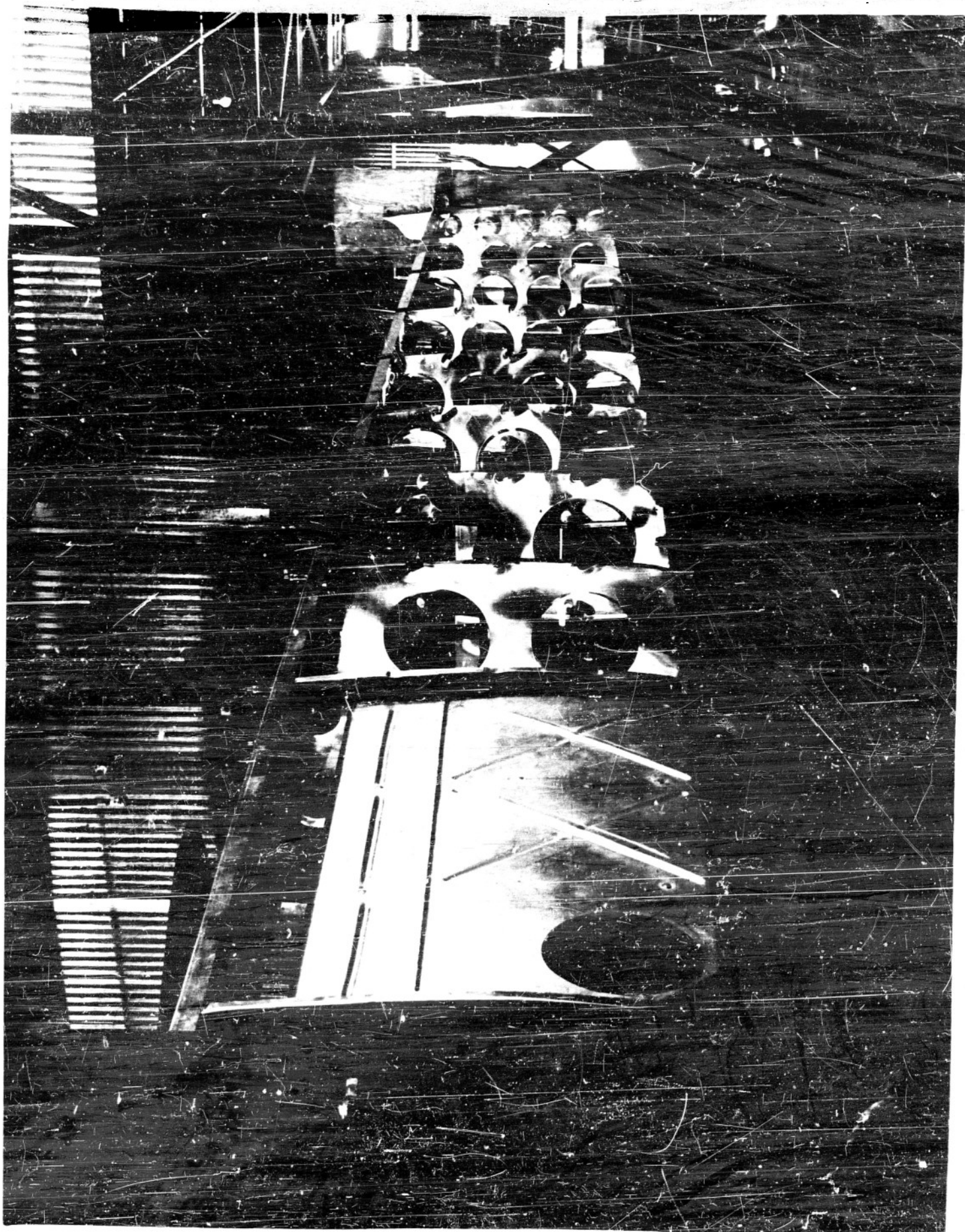
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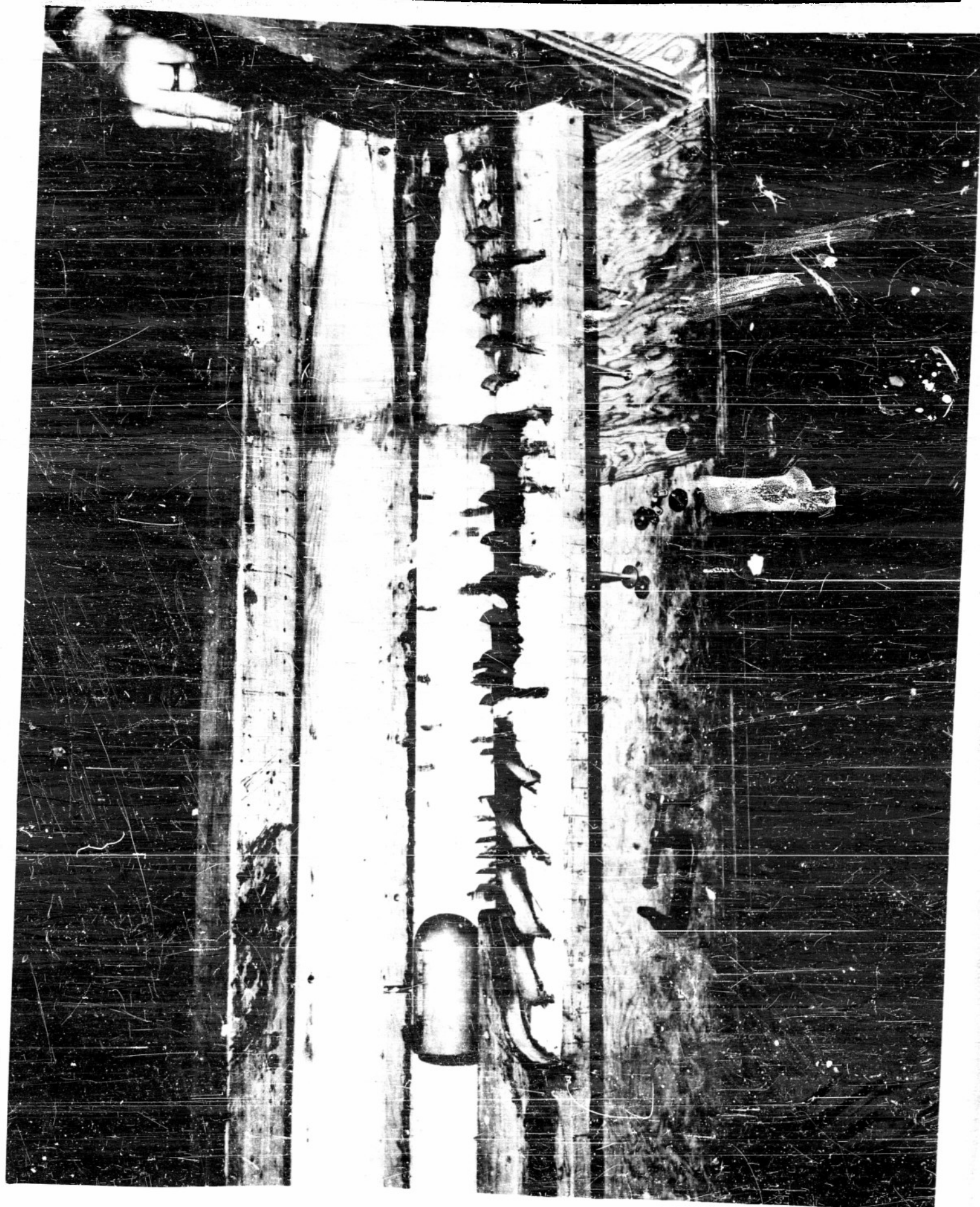
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Photograph No. 4



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MODEL 300A-300C-310

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Photograph No. 5

